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SIX NEW SPECIES OF SHALLOW-WATER MARINE DEMOSPONGES FROM CALIFORNIA

Donn A. Ristau

Abstract.—A compositional and distributional study of intertidal and shallow subtidal (to –31 meters), central and north-central California marine demosponges was conducted between 1972 and 1977. As a result of that study, six species are described as new: *Xestospongia trindanea, Adocia dubia, Toxadocia zumi, Leucophloeus actites, Axinomimus tuscarus,* and *Artemisina archegona.*

The study of California sponges has not generated a fervor of activity over the years, nor has the literature been saturated with information about this little-studied west coast phylum. Probably the greatest interest generated by sponges occurred recently, when several news agencies reported that giant, and presumably mutant, sponges were found growing on undersea nuclear waste storage containers (see Editor's Comment, San Francisco Chronicle, September 14, 1976). It has been rumored that the Japanese are now planning a motion picture in which a sleeze[1] of giant sponges rises from the depths of the Farallon Islands and phagocytizes the North Beach area of San Francisco. Undoubtedly, when this epic materializes, research and interest in California sponges will increase. Until that time, however, those interested in the sponge fauna of this area must be content with the paucity of scientific literature on this subject.

Ten references prior to 1932 deal with California's marine sponge fauna: Haeckel (1872), Lendenfeld (1889, 1910), Lambe (1894), Schulze (1899), Urban (1902, 1905) and de Laubenfels (1926, 1927, 1930). According to de Laubenfels (1932) some of this work is inadequate, incorrect or describes material from outside the California area.

De Laubenfels's (1932) monograph on marine and freshwater sponges is still one of the most complete guides to date for the identification of California sponges. In this work, 101 species from 3 classes (Hyalospongiae, Calcispongiae and Demospongiae) are discussed. Most specimens are from southern and central California, and most (76%) are members of the Demospongiae.

Major discussions of parts of the sponge fauna, after 1932, are given by Hartman and Smith (1954), Ricketts and Calvin (1968) and Hartman (1975). These authors predominantly discuss intertidal species of central and southern California. The species listed in Hartman and Smith (1954) and Ricketts and Calvin (1968) are, for the most part, those listed in de Laubenfels (1932). Hartman's (1975) key has been systematically updated and includes

material previously unreported from California. The 1975 key is not complete in that some species, previously listed as occurring intertidally, are not mentioned (*Paresperella psila*, *Prianos problematicus*, *Myxilla parasitica*—see de Laubenfels (1932), Hartman and Smith (1954) and Bakus (1966) for systematic revision of 2 of these species).

North (1976) lists many subtidal California sponges, but some species identifications are questionable and the distributional data are sometimes incomplete.

The following works discuss material from outside California, yet they add pertinent information about the morphology and distribution of certain species that do occur in the state: Lambe (1893, 1894, 1895), Dickinson (1945), de Laubenfels (1935, 1961), Bakus (1966), Koltun (1959, 1966) and Kozloff (1974).

The majority of work done on California sponges has been concerned with intertidal species from the central and southern parts of the state. Very little research has been done on the sponge fauna of northern California, or on the subtidal fauna. Between 1972 and 1977, compositional and distributional data were collected by the author from three major areas in California (Ristau, 1977): southern California, central California (Carmel Bay area), and north-central California (Bodega Head, central Sonoma coast and north Sonoma coast) (Fig. 1). The identification and description of 6 new species has resulted from that investigation.

Materials and Methods

In situ collection and photography of all subtidal material was accomplished by SCUBA diving. Collected specimens were preserved in 95% ethyl alcohol (ETOH) or dried. Samples to be examined by scanning electron microscopy (SEM) were prepared in one of several ways: (1) preserved in ETOH and then air dried; (2) preserved in a 95:5 part mix of ETOH: glycerine and air dried; or (3) preserved in ETOH, oxidized 8–48 hours in 30% hydrogen peroxide and air dried. All SEM samples were triple coated with either gold or platinum. SEM photographs (Figs. 4–6) were taken with Polaroid Positive-Negative film (type 105) on a Cambridge Stereoscanner Electron Microscope at the Facility for Advanced Instrumentation, University of California, Davis.

Species identifications are based on spicular complement and skeletal arrangement. Spicule mounts were made by standard techniques. Spicule measurements are expressed in micrometers (μm) and average sizes are based on 25 randomly selected spicules. Maximum and minimum sizes were determined by searching for size extremes in an 18 mm^2 quadrant of a spicule preparation. Figures of the spicules were drawn freehand during their examination through a compound light microscope, or they were redrawn from SEM photographs.

The systematic scheme used herein is a combination of those used by

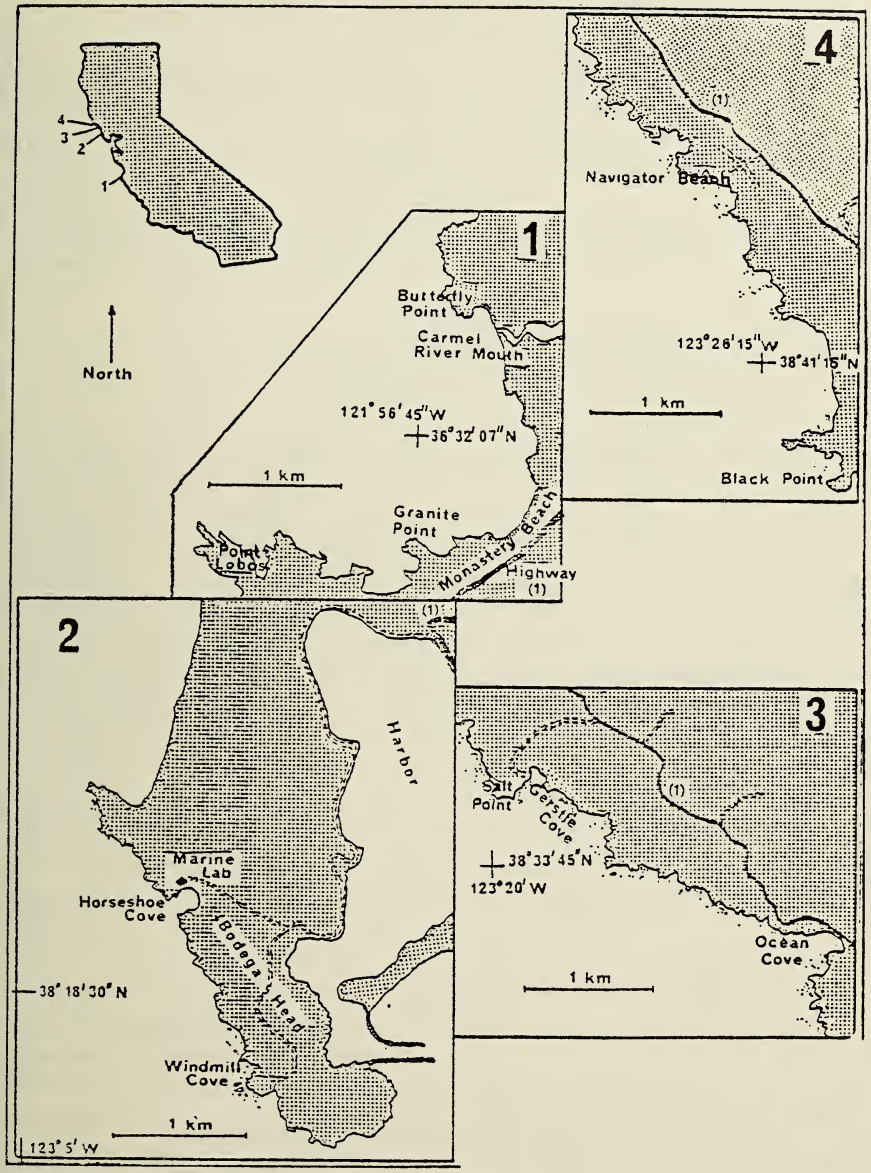

Fig. 1. Central and North-Central California collecting areas.

de Laubenfels (1936) and Levi (1960). Deviation from de Laubenfels's scheme is found in the diagnosis of *Artemisina archegona.*

Holotypes, along with spicule mounts and some paratypes, have been deposited in the National Museum of Natural History (USNM). Specimens

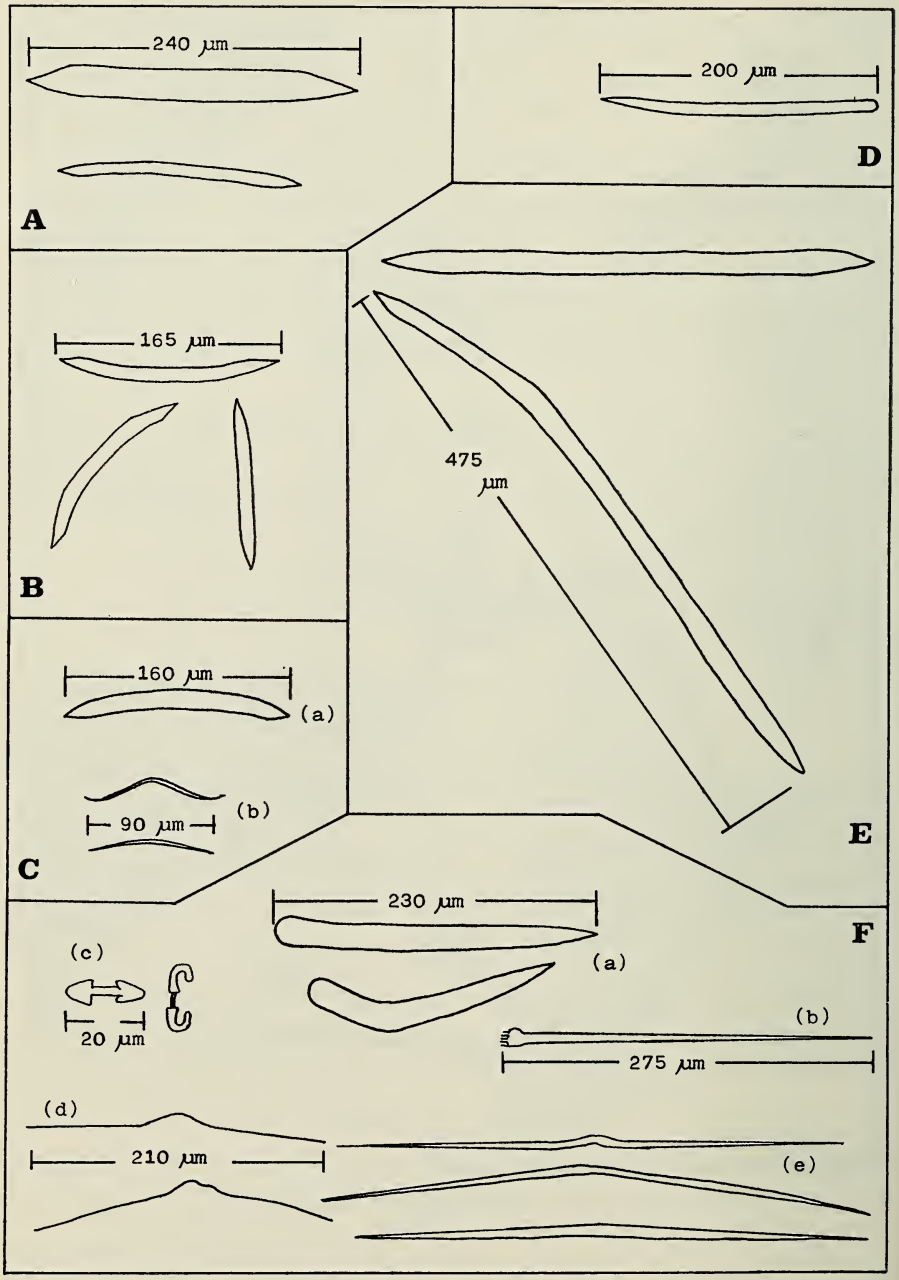

Fig. 2. A, *Xestospongia trindanea*, oxeas of both size ranges; B, *Adocia dubia*, oxeas; C, *Toxadocia zumi*, (a) oxea, (b) toxas; D, *Leucophloeus actites*, style; E, *Axinomimus tuscarus*, oxeas; F, *Artemisina archegona*, (a) styles, (b) subtylostyle with microspined head, (c) palmate isochelas, (d) toxas, (e) toxiform oxeas.

mounted on SEM plugs are included with some holotype material. Holotype spicule mounts and some paratypes will also be placed in the British Museum (Natural History). Holotype spicule mounts and paratypes have been included in the Bodega Marine Laboratory synoptic collection. Access to this material may be obtained by contacting the curator of the collection.

Unless otherwise stated, all holotypes are preserved in 95% ETOH. Paratypes may either be in ETOH or dried.

All intertidal and subtidal depths listed in "Localities" are measured from mean low water (MLW).

Haliclonidae

Xestospongia de Laubenfels, 1932

Xestospongia trindanea, new species

Figs. 2A, 3a, 4a, b

Holotype and type-locality.—USNM 24521, Carmel River Beach Point, Carmel, California.

Known range.—Pacific Coast of North America, from Carmel north to Sea Ranch, Sonoma County, California.

Localities.—Carmel River Beach Point, 2 specimens, –5 to –8 meters (m), 12 April 1973. Horseshoe Cove, Bodega Head, 18 specimens from wrack, between 1 August 1975 and 1 February 1977. Horseshoe Cove, Bodega Head, 2 specimens, –6 m, 6 September 1976. Horseshoe Cove, Bodega Head, 1 specimen intertidally, –0.15 m, 11 April 1976. Ocean Cove, Sonoma County, 1 specimen, –7 m, 28 November 1976. Sea Ranch, Sonoma County, 3 specimens, –2 to –8 m, 6 June 1974. This sponge occurs rarely in the intertidal and occasionally subtidally.

Description.—An encrusting or erectly lobate sponge that inhabits exposed, rocky substrates. Color, alive and dried, dark brown. In ETOH color may fade to light cinnamon. Color of interior lighter brown than that of exterior.

Consistency firm and hard, slightly compressible. Thicknesses of encrusting forms from 4–12 mm. Holotype, erect and laterally compressed, 8 × 3 × 5 cm high (Fig. 3a).

Surface slightly hispid with spicules projecting 60–80 μm above it. Ectosomal membrane raised slightly at point of contact with spicules, making surface conulose. Ectosome without special skeleton. Pores 10–20 μm in diameter. Oscula of holotype arranged in fairly well defined lineations. Oscula 1.5–5.0 mm in diameter, flush with surface. In other specimens, oscula spread irregularly over surface, 0.6–3.5 mm in diameter.

Interior appears solid and fleshy. Endosomal skeleton consists of rectangular reticulations of large, well defined multi-spicular tracts and of spicules strewn in confusion in-between (Fig. 4a). Major multi-spicular tracts, 100–160 μm wide, usually cored with 8–10 spicules. Rectangular meshwork variable in size, usually 200–800 × 100–400 μm (length × width). Oxeas of

major spicule tracts uniform in size. Interstitial oxeas smaller and more variable (Fig 4b). Interior reticulate pattern more discernible in dried material than in alive or ETOH preserved specimens.

Reproductive bodies (similar to those described by de Laubenfels 1932: 84, 107; Bakus 1966:456, 473) found in Carmel specimens in April and in Horseshoe Cove specimens in March. Reproductive bodies light beige in color; about 210 μm in diameter; located throughout entire body of sponge.

Spicules consist of megascleres of oxeas, two fairly distinct sizes, 240–260 × 18–20 μm and 115–200 × 2–8 μm; (Fig. 2A).

Taxonomic discussion.—De Laubenfels (1932) erected the genus *Xestospongia*, which is characterized by "having only oxeas as spicules and these so abundant that any reticulate arrangement is obscured; there is no special dermal skeleton." Two species of *Xestospongia* (*X. diprosopia*, *X. vanilla*) have previously been described from California (de Laubenfels, 1932:115–116). Their general morphology and color are quite distinct from *X. trindanea*, and neither show the double size range of oxeas that is common in *X. trindanea.*

Lambe (1895:115) discussed a sponge from Middletown Island (Alaska/Canada area) which he identified as *Petrosia hispida* Ridley & Dendy, 1886. His brief description raises the possibility that it may be conspecific with *X. trindanea.* Lambe's specimen was a rich brownish-yellow in ETOH, had numerous oscula 1.5 mm in diameter and spicules from 242–327 × 16–26 μm. Lambe did not discuss the interior skeletal arrangement.

Ridley & Dendy's (1886, 1887) description of *Petrosia hispida* is of a lobate, yellowish-gray, papillate, brittle sponge with a hispid surface. The spicules were oxeas of one size only (370 × 21 μm). The sponge was collected at Royal Sound, Kerguelen Island (extreme South Indian Ocean) at –48 meters.

According to de Laubenfels (1932), Ridley & Dendy's (1887) definition of the genus *Petrosia* included two distinct generic types; sponges with a distinct dermal skeleton and strongyles and oxeas as spicules, and sponges without any dermal specialization and only oxeas as spicules. De Laubenfels erected the genus *Xestospongia* for this latter group. In discussing species of *Petrosia* that Ridley & Dendy described, but de Laubenfels felt should be placed in the genus *Xestospongia*, *P. hispida* was not mentioned as needing reassignment. However, based on the published description of this sponge, is seems justifiable to reallocate it. Due to the fact that *X. hispida* possesses only one size range of oxeas, and considering the general morphology, coloration and area of collection, I feel that *X. trindanea* is distinct from *X. hispida.*

The specific identity of Lambe's specimen is therefore somewhat problematical. I believe a reasonable doubt exists whether his specimen is conspecific with the Indian Ocean sponge. However, Lambe's description is not detailed enough to allow it to be identified with *X. trindanea* and at this time the identity will have to stand as *X. hispida.*

It is my pleasure to dedicate this species to my wife, Trinda, whose name has been used in the formation of the specific name.

Adociidae
Adocia Gray, 1867
Adocia dubia, new species
Figs. 2B, 3b, 4c, d

Holotype and type-locality.—USNM 24522, Horseshoe Cove, Bodega Head, Sonoma County, California.

Known range.—Pacific Coast of North America, from Bodega Head north to Sea Ranch, Sonoma County, California.

Localities.—Horseshoe Cove, Bodega Head, 1 specimen intertidally, –0.15 m, 11 April 1976. Horseshoe Cove, Bodega Head, 5 specimens from wrack, between 1 August 1975 and 1 February 1977. Sea Ranch (Navigator Beach), Sonoma County, 1 specimen, –3 m, 8 February 1974. Ocean Cove, Sonoma County, 1 specimen, –7 m, 22 August 1977. The sponge occurs occasionally in the subtidal and rarely in the intertidal.

Description.—An encrusting sponge found on exposed rock surfaces subtidally or cryptically in the intertidal. Color, alive, in ETOH and dried is white.

Consistency (wet and dry), very firm and non-compressible. Dry, the sponge is fairly friable. All specimens were laterally spreading encrustations, ranging in thickness from 4–8 mm. Holotype, about 3 cm in diameter, cut from a larger mass.

Surface smooth and level, except where volcano-like oscular rims project 0.5–1.5 mm (Fig. 3b). In other specimens, oscula flush with surface. In holotype, oscula spaced 3–5 mm apart over entire surface. In others, exhalent vents dispersed irregularly and have diameters from 0.8–1.3 mm. Pores, 10–30 μm in diameter. Pinacodermal membrane supported in a 50 μm thick tangential ectosomal layer. Tangential oxeas arranged in tracts (2–5 spicules wide) which form an irregular polygonal network with 120–140 μm meshes (Fig. 4c).

Pattern of circular areas often evident below surface. These areas represent beginnings of inhalent canal system. Diameters of areas usually 400–500 μm. Thickness of walls that outline the areas, 300–400 μm. Well defined subectosomal spaces in type; dermal layer supported by columns of erect oxeas (4–10 spicules wide). Subectosomal spaces not as evident in other specimens.

Interior varies from well defined reticulation of multi-spicular tracts to confused arrangement. Multi-spicular tracts usually 6–10 spicules wide. Thin, spiculiferous membranes often evident between reticulations. Some specimens exhibit growth lines (Fig. 4d), representing old ectosomal layers.

Specimen from Sea Ranch contains orange-brown (spongin?) fibers, cored with oxeas, in interior. Similar fibers noted in one wrack deposit specimen.

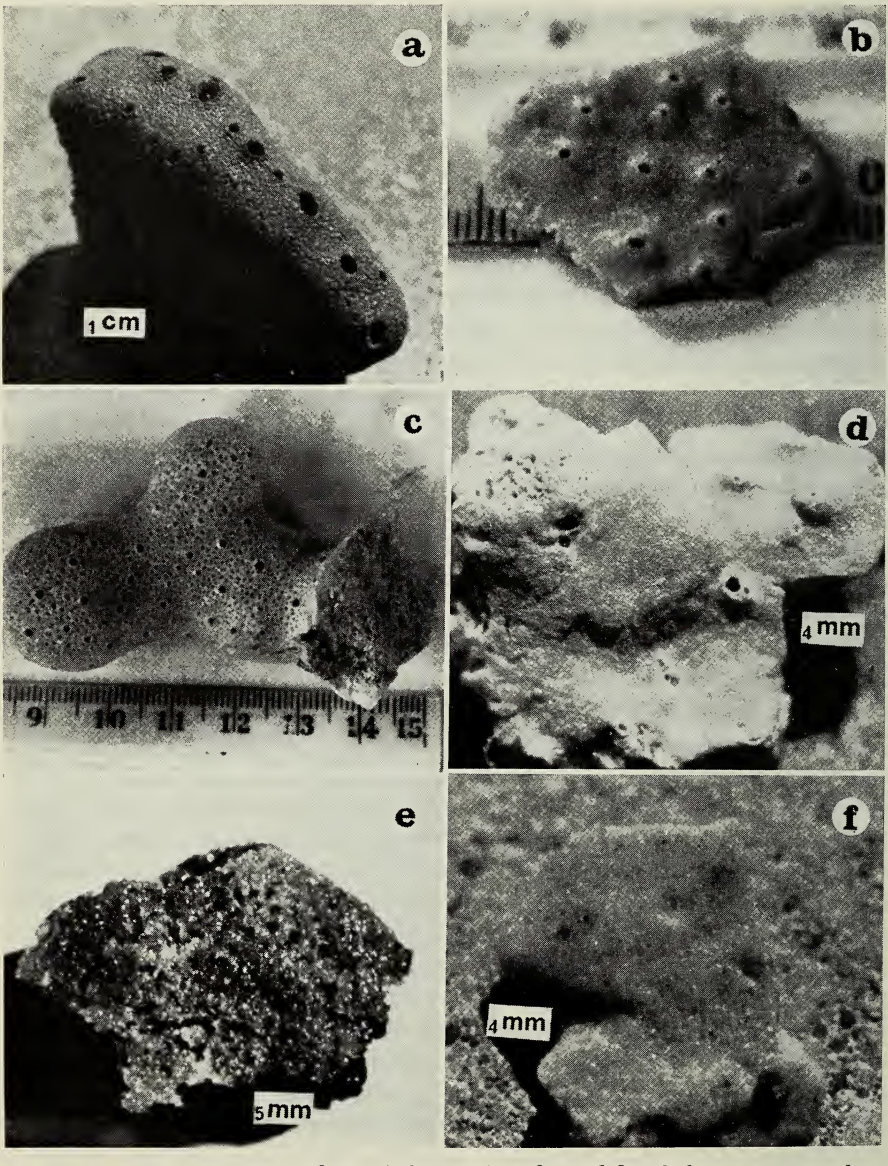

Fig. 3. a, *Xestospongia trindanea*, holotype; b, *Adocia dubia*, holotype; c, *Toxadocia zumi*, holotype; d, *Leucophloeus actites*, holotype; e, *Axinomimus tuscarus*, holotype; f, *Artemisina archegona*, holotype.

Specimens with fibers were not overgrown or attached to other organisms. Fiber origin, at this time, uncertain although they appear to be part of sponge.

Reproductive bodies, white in color, about 250 μm in diameter, noted in specimen collected in August; located throughout the interior.

Spicules consist of megascleres of oxeas, straight to slightly curved, some bent at 2 points, 140–180 × 10–16 μm (Fig. 2B).

Taxonomic discussion.—The characteristics of *Adocia dubia* (white, encrusting, hard, reticulate interior often obscured by spicules in confusion, and the shape of some spicules) are similar to those of *Xestospongia vanilla* (de Laubenfels, 1932; Hartman, 1975). The major distinction between these 2 species is the presence of a tangential ectosomal skeleton in *A. dubia.* De Laubenfels (1932, 1936) has often stressed that the genus *Xestospongia* does not possess a special dermal skeleton and it is for this reason that I believe the 2 species are distinct.

The only species of *Adocia* previously described from California is *A. gellindra* (de Laubenfels, 1932:114). This sponge was originally described as *Halichoclona gellindra,* a fragile, pale lavender, encrusting form from Carmel, California. Based on its published description it is quite distinct from *A. dubia,* and in fact Hartman (1975) has questioned the status of the species, claiming it may be identical to *Reniera* sp. A (which does not have a tangential ectosomal skeleton).

Dickinson (1945:10) described *Adocia ambrosia* as a ramose drab sponge from Mexico containing 2 size categories of oxeas. Its description indicates it is distinct from *A. dubia.*

I am rather dubious of the generic placement of *A. dubia* (hence the specific name) due to the fact that the reticulate interior may be obscured by spicules in confusion (as in *Xestospongia*) and that some specimens appear to develop fibers cored with oxeas (as in *Pachychalina*; see Hartman, 1975). I am tentatively placing this sponge in the genus *Adocia* because of the presence of a well defined tangential ectosomal skeleton, the simple spiculation and the presence of subpinacodermal cavities (de Laubenfels, 1936:39).

Toxadocia de Laubenfels, 1936
Toxadocia zumi, new species
Figs. 2C, 3c, 5a, b

Toxadocia sp. North, 1976:151.

Holotype and type-locality.—USNM 24524, Monastery Beach, Carmel, California.

Known range.—Pacific Coast of North America, from Carmel south to La Jolla, California.

Localities.—Monastery Beach, Carmel, 6 specimens, –12 to –18 m, between 1973 and 1976. Holotype collected 12 April 1973. Carmel River Beach Point, 2 specimens, –10 to –15 m, 6 June 1975. La Jolla, 1 specimen, –21 m, 4 June 1976 (collected by G. Zumwalt). This sponge is common at depths below –10 m at the type-locality.

Description.—An erectly branching sponge found on rock substrates in semi-cryptic environments (protected by overhanging ledges or in the interstices of boulder piles) or, occasionally, in exposed areas. Color, alive, in ETOH, and dried, white. Holotype dried, dichotomously branched, 6.5 cm high. Diameter of branches, about 2.0 cm. Branches may be cylindrical or compressed into lobes. Lobate forms often palmate or fan-shaped.

Consistency firm and rigid. Coral-like in appearance, due to ectosomal skeletal construction and regular disposition of oscula (Fig. 3d). Largest specimen noted, a palmate form, 17 × 5 × 18 cm (width × thickness × height).

Surface hispid. Spicule bundles erect on well defined tangential layer of oxeas (Fig. 5a). Tangential layer, 60–80 μm thick. Ectosomal membrane supported by erect spicule bundles 140–150 μm above tangential layer. Tips of spicule bundles project 10–20 μm above ectosomal membrane. Membrane thin, transparent, difficult to detach; contains oxeas and toxas. Pores, 10–30 μm in diameter. Oval inhalent areas, 240–400 μm in diameter, give tangential layer a honeycomb appearance. Thickness of walls defining each inhalent area from 200–500 μm. Oscula generally 1.0–1.5 mm in diameter, spaced 5–10 mm apart over entire surface. Vertical spicules surround each osculum, giving oscula elevated and fringed appearance.

Interior of multi-spicular tracts of oxeas running perpendicularly toward surface. Single spicules, united isodictyally, in confusion between spicule tracts. Tracts normally 6–10 spicules wide, spaced about 200 μm apart. Growth lines, representing old tangential layers, frequently found in interior. Former oscula discernible in these older layers. Growth lines disappear near centers of branches. Distance between successive lines has ranged from 1–4 mm. Maximum number of growth lines observed in a single branch, 5; initial indications that growth lines may be annual. However, sponge may be able to resorb or reorganize older layers, in which case accurate age determinations may not be possible. Reproductive bodies not noted in any specimens.

Spicules consist of megascleres of oxeas, 115–200 × 6–14 μm (most are 160–180 × 12 μm); microscleres of toxas, variable in shape, some with a high arch and recurved arms, others with low arches and straight arms, 50–96 × 0.5–1.0 μm (Fig. 2C).

Taxonomic discussion.—De Laubenfels (1936:69) erected the genus *Toxadocia* for sponges having the structure and megascleres of *Adocia* (special tangent dermal skeleton, isodictyal reticulate interior and oxeas as spicules) and only toxas as microscleres.

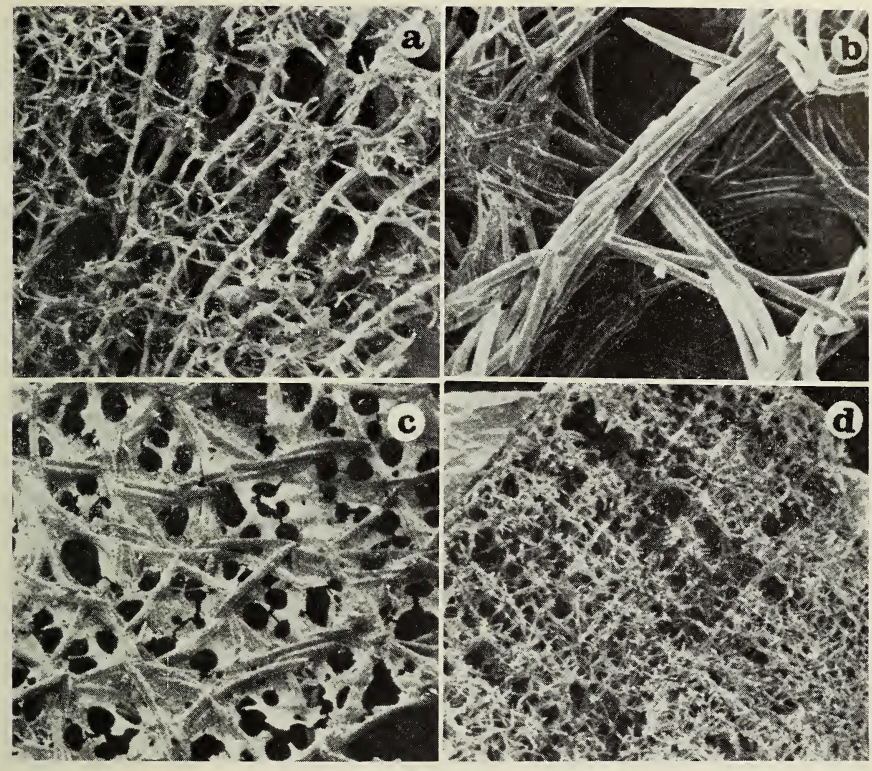

Fig. 4. a, *Xestospongia trindanea*: oxidized specimen showing reticulate pattern of multi-spicular tracts and confused arrangement of interstitial spicules (20×); b, *Xestospongia trindanea*: large oxeas of multi-spicular tracts and smaller interstitial oxeas (lower right) (100×); c, *Adocia dubia*: ectosomal tangential skeleton, ectosomal membrane and pores (125×); d, *Adocia dubia*: oxidized specimen showing reticulate pattern and several growth lines (running from upper right to lower left) (20).

Lambe (1895:115) described *Toxochalina borealis* from Kyska Harbor (Alaska), and based on his description this sponge should belong in the genus *Toxadocia*. The oxeas of the Alaskan sponge are comparable in size to those of *T. zumi*, however, Lambe's specimen has larger toxas and a markedly different morphology (encrusting, soft and spongy and yellow-brown in color) and is distinct from *T. zumi*.

Hartman (1975:60) listed *Toxadocia* sp. as occurring intertidally in central California, but claimed this sponge is uncommon and that more than one species may be present. The description of *Toxadocia* sp. (encrusting, olive-beige, pale gray-brown or deep chrome yellow in color, oxeas 120 × 7 μm and toxas 65 μm) is quite different from that of *T. zumi* and I believe the species are not conspecific. North (1976:151) pictured and listed a sponge (*Toxadocia* sp.) that is undoubtedly conspecific with *T. zumi*.

Although the surface of this sponge is hispid and the ectosomal membrane supported by erect spicules, and although the interior shows a combination of reticulate and confused structures, I have placed this species in the genus *Toxadocia.* There is a well defined subpinacodermal tangential skeleton and the spicule complement corresponds sufficiently well to de Laubenfels's generic description to allow placement in this genus.

It is my pleasure to dedicate this species to Gary S. Zumwalt, whose name has been partly used in the formation of the specific name.

Halichondriidae
Leucophloeus Carter, 1883
Leucophloeus actites, new species
Figs. 2D, 3d, 5c, d

Holotype and type-locality.—USNM 24526, Horseshoe Cove, Bodega Head, Sonoma County, California.

Known range.—Pacific Coast of North America, from Bodega Head north to Ocean Cove, Sonoma County, California.

Localities.—Horseshoe Cove, Bodega Head, 3 specimens, intertidally, –0.16 m, 6 January 1977. Horseshoe Cove, Bodega Head, 7 specimens from wrack, between 1 August 1975 and 1 February 1977. Ocean Cove, 1 specimen, –5 m, 22 August 1977. This sponge occurs occasionally in the intertidal and subtidal in north-central California.

Description.—An encrusting sponge found on exposed rock surfaces or semi-cryptically under ledges and in kelp holdfasts. Color, alive, bright yellow. Dried and in ETOH, a white exterior and a light yellow or white interior. Holotype is dried, 2.7 cm in diameter, 1 cm thick, amorphous in shape. Consistency, when alive, firm but flexible; dried, firm but easily friable. In situ, color, growth form and surficial characteristics very similar to *Halichondria panicea.*

Surface smooth, with irregular contour. Tangential ectosomal skeleton present, well defined, easily removed, 80–120 μm thick (Fig. 5c); consisting of several ill-defined layers (1–2) of horizontal styles. Ectosomal styles either formed into multi-spicular tracts (usually 2–5 spicules wide) and united into regular polygonal network, or matted together into smooth, solid surface (Fig. 5d). Semi-transparent ectosomal membrane evident in areas of polygonal meshwork; not as evident in matted areas. Pores 10–30 μm in diameter. Few oscula, 0.3–1.3 mm in diameter, scattered irregularly over surface; often situated on slightly raised mounds. Areas directly around oscula smoothly matted.

Interior fairly compact; appears fleshy. Subpinacodermal spaces generally well defined. Ectosomal skeleton supported by compact multispicular tracts although occasionally it rests directly on spiculation of

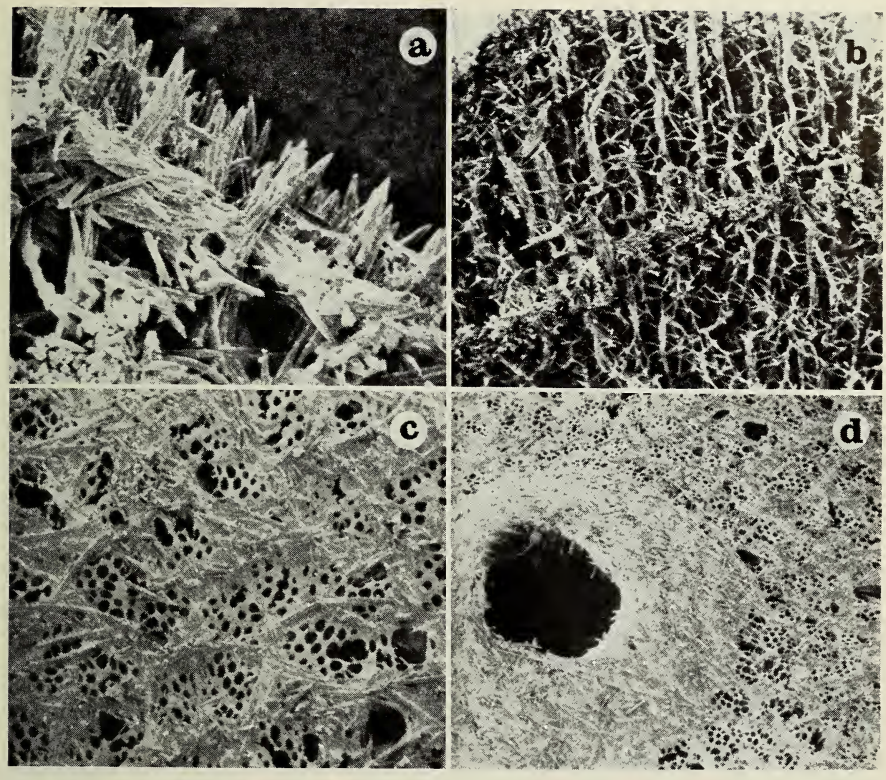

Fig. 5. a, *Toxadocia zumi*: surface cross-section showing erect spicules on tangential layer (100×); b, *Toxadocia zumi*: oxidized specimen showing reticulations and old tangential layer (concentration of spicules near center) (22×); c, *Leucophloeus actites*: ectosomal tangential skeleton, ectosomal membrane and pores (110×); d, *Leucophloeus actites*: osculum and smoothly matted area around osculum contrasted to polygonal arrangement of spicules (55×).

interior. Interior spiculation confused; styles pointing in all directions; rarely organized into fibers or tracts. Reproductive bodies not observed.

Megascleres of styles, smooth and gently curved, occasionally sinuous or irregularly bent, 165–220 × 4–8 μm (Fig. 2D).

Taxonomic discussion.—According to de Laubenfels (1936:135), the genus *Leucophloeus* belongs in the family Halichondriidae, whose members possess a special dermal skeleton, a confused interior and simple spiculation. De Laubenfels stated that *Leucophloeus* resembles *Ciocalypta*, which also has styles, but *Ciocalypta* has large subpinacodermal spaces, over which the dermal skeleton is supported by lengthy spicule columns. In *Leucophloeus*, the subpinacodermal structure is more compact. *Ciocalypta* also differs in that it has fistulous processes.

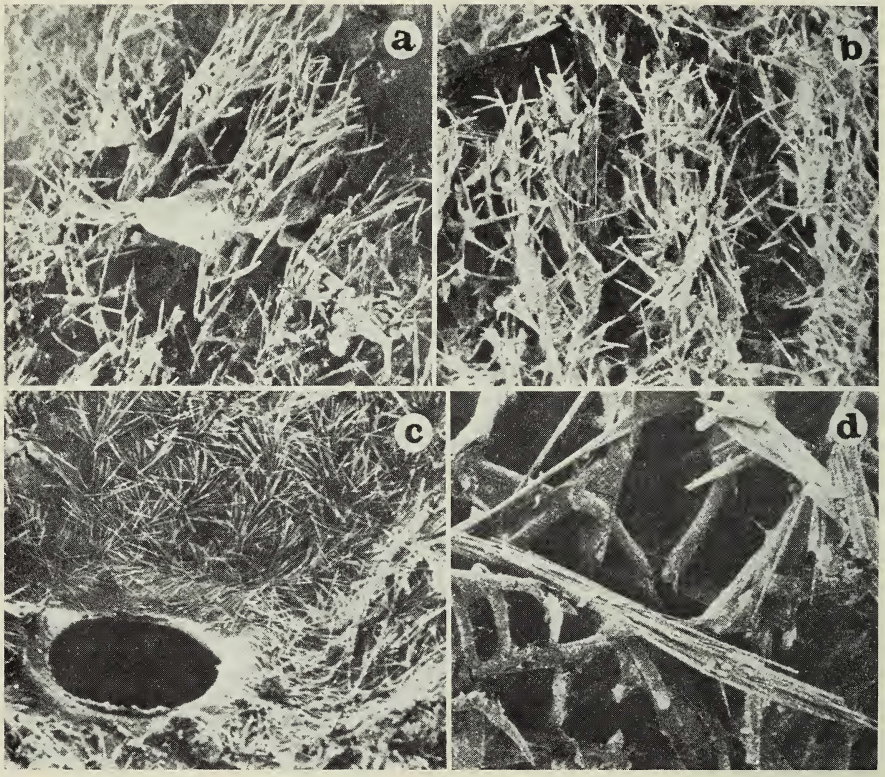

Fig. 6. a, *Axinomimus tuscarus*: spicule brushes shown projecting through fragment of ectosomal membrane (white area in center) (20×); b, *Axinomimus tuscarus*: vague spicule tracts and echinating spicules branching from tracts are shown (25×); c, *Artemisina archegona*: oscular area showing contractile membrane and radiating ectosomal spicules (50×); d, *Artemisina archegona*: fibrous bundles of toxiform oxeas in interior (130×).

No other species of *Leucophloeus* has ever been described from the west coast of North America. Thiele (1898:47–48) briefly described 2 species of *Leucophloeus* (*L. perforatus*, *L. incrustans*) from the Pacific area near Japan. Both forms had large tylostyles (1.0–1.6 mm length) and, based on their descriptions, are quite different from the California sponge. A third specimen, designated by Thiele as *Leucophloeus* sp. (p. 48), has styles from 250–500 × 6–20 μm. Another specimen, identified as *Leucophloeus* (?) sp. (p. 49), had styles from 160–180 × 10–12 μm. The spicule sizes of these latter forms approach those of *L. actites*, however nothing more of these Western Pacific sponges is known due to the brevity of Thiele's descriptions.

The genus *Hymeniacidon* shows some slight similarity to *Leucophloeus*

and thus deserves mention. *Hymeniacidon* (Family Hymeniacidonidae, de Leubenfels 1936:136) is characterized by a fleshy ectosome, without a profusion of erect spicules. The dermis is always skin-like, contains few, if any spicules and those present are usually tangential. The interior is confused. A local species of this genus (*H. ungodon* de Laubenfels 1932:60) has spicules similar to those of *L. actites*, but, specimens of *H. ungodon* I have collected are very different in terms of coloration, growth form and disposition of the ectosomal skeleton.

I have chosen to place this new species in the genus *Leucophloeus* because it resembles members of the Halichondriidae more than those of the Hymeniacidonidae. The name "actites" is formed from the root word "actit," which means "dweller of the sea coast" (see Jaeger, 1963).

Sollasellidae
Axinomimus de Laubenfels, 1936
Axinomimus tuscarus, new species
Figs. 2E, 3e, 6a, b

Holotype and type-locality.—USNM 24527, Carmel River Beach Point, Carmel, California.

Known range.—Pacific Coast of North America, from Carmel north to Bodega Head, Sonoma County, California.

Localities.—Carmel River Beach Point, 1 specimen, –7 m, 10 April 1973. Horseshoe Cove, Bodega Head, 3 specimens, from wrack, between 1 August 1975 and 1 February 1977. This sponge occurs rarely at the type-locality. It has not been collected in situ at Bodega Head.

Description.—A thick encrusting sponge, found on exposed rock surfaces. Holotype formed an amorphous mass, intermixed with worm tubes; measures 3 × 2 × 1.5 cm thick; cut from larger mass. Color, alive and dried, light to medium dark brown exterior and dark chocolate brown interior. In ETOH colors fade slightly. Dried specimens from Horseshoe Cove, light tan in color; may represent surface area of sponge only. Consistency, alive and in ETOH, soft, slightly spongy, compressible; dried, brittle and very friable.

Surface very hispid. Single spicules or bundles (brushes) projecting 0.2–1.5 mm in various directions through ectosomal membrane (Fig. 6a). Projecting brushes often united with other brushes by cross-spicules connected in irregular and semi-isodictyal manner. No special ectosomal skeleton. Ectosomal membrane thin (10 μm), semi-transparent, difficult to detach. Membrane normally recessed below tips of spicule bundles, occasionally flush with spicule tips. Pores not evident. Oscula? appearing as irregular openings (0.4–1.0 mm in diameter) in membrane; dispersed irregularly over

entire surface. Circular areas (usually 1 mm in diameter), and occasionally sinuous troughs, outlined by projecting spicule bundles; in places projecting spicules packed closely together, no circular areas or troughs evident. Dark colored pigment granules noted in lighter-colored surface area; quantity of granules may increase in older parts of sponge, causing noted color change.

Alive and in ETOH, interior gelatinous; skeletal construction not evident as only spicule tips seen projecting from gelatinous matrix. Dried, interior cellular material reduced in volume, granular in appearance; skeletal construction easily visible. Skeleton consisting of vertical multi-spicular tracts (vague to moderately well defined) plus confused arrangement of connecting spicules. Tracts normally 40–80 μm wide, containing 2–5 spicules; appear to branch and anastomose. Echinating cross-connecting spicules branch from tracts; unite isodictyally in confused arrangement (Fig. 6b). Presence of tracts often masked by confused echinating arrangement.

Megascleres of oxeas, slightly curved or irregularly bent, 380–530 × 10–22 μm, most 440–480 × 18 μm (Fig. 2E).

Taxonomic discussion.—The genus *Axinomimus* was erected by de Laubenfels (1936:163), with *Axinella paradoxa* Ridley & Dendy, 1886 (and 1887:187) being the genotype. The published description of *Axinomimus paradoxa* (massive, lobate, rubber-like, oxeas of 870 × 22 μm, from the South Atlantic Ocean) is sufficiently different to necessitate separation from *A. tuscarus*.

Brøndsted (1923:119) described *Halichondria intermedia* from the Auckland and Campbell Islands (New Zealand). He hesitatingly placed the sponge in this genus because the skeleton approached the Axinellid-type. Brøndsted's description stated the spicules were collected in indefinite fibers; the number of spicules in the fibers were from a few to 10 or more; and numerous spicules projected from the fibers in an Axinellid manner and lie scattered and disorderly. Brøndsted stated, "the sponge in hand is very interesting in taking up a median position between the Halichondriae and Axinellidae; other species do the same, e.g. *Axinella paradoxa* Ridley & Dendy." The spicules of *H. intermedia* were oxeas, 410–550 × 12–13 μm.

Bergquist (1970:34), in a review of the axinellids and halichondrids of New Zealand, stated that the type of *H. intermedia* was unavailable for study. Bergquist did not comment further on the systematic position of this species, although it seems that the sponge could be reallocated to the genus *Axinomimus*. However, considering that the type is unavailable, it should remain as *H. intermedia*. The question of conspecificity with *A. tuscarus* is not resolvable although certain similarities are evident.

Axinomimus tuscarus is the first sponge of this genus to be described from the Pacific Ocean. The specific name has been formed from the adjective root word "tuscar," meaning "in the Pacific Ocean" (see Jaegar, 1963).

Clathriidae
Artemisina Levi, 1960
Artemisina archegona, new species
Figs. 2F, 3f, 6c, d

Holotype and type-locality.—USNM 24528, Monastery Beach, Carmel, California.

Known range.—Pacific Coast of North America, in the Carmel Bay area.

Localities.—Monastery Beach, 1 specimen, –6 m, 8 April 1974. Carmel River Beach Point, 1 specimen, –5 m, 9 April 1974. This sponge occurs occasionally at the type-locality.

Description.—A thin encrusting sponge found on exposed rock substrates. Color, alive, bright orange; in ETOH, fades to white. Consistency, alive and in ETOH, firm yet slightly compressible; dried it is very friable. Holotype, 2.0 × 1.3 × 0.7 cm thick; cut from a laterally spreading mass 10 × 10 cm in area.

Surface minutely hispid. Projecting spicules appear to radiate in all directions, but SEM work shows only certain spicules (toxas, toxiform oxeas, subtylostyles) to radiate (Fig. 6c). Styles project vertically, 250–300 μm, through ectosomal membrane. Membrane, thin (10 μm), semi-transparent, difficult to detach. Few tangentially placed subtylostyles, toxas, and chelas in membrane but no special tangential skeleton. Pores, 30–40 μm in diameter; often localized in shallow, circular depressions (0.3–0.5 mm diameter). Oscula, about 0.6 mm in diameter, situated in larger (1.0–1.5 mm diameter) surficial depressions (Fig. 6c). Contractile membranes surround each osculum. Surficial depressions not as apparent in Carmel River Beach Point specimen.

Wet, interior appears fleshy and dense. Dried, endosomal material appears granular; interior cavernous, skeletal construction evident. Skeleton of vague tracts of styles (2–5 spicules wide) running more or less perpendicularly toward surface. Tracts connected by single or multiple-style tracts showing no well defined orientation. Vague reticulate network becomes confused as fibers (40–80 μm wide) of toxas and toxiform oxeas course randomly through interior (Fig. 6d); fibers often appear to branch and anastomose. Single toxiform oxeas and (rarely) subtylostyles dispersed in interior. Small toxas and palmate isochelas in interior membranes or attached to larger spicules. No echinating spicules.

Reproductive bodies, 400–500 μm in diameter; located near base of sponge.

Megascleres of styles, smooth, slightly curved or sharply bent, 185–240 × 7–20 μm; subtylostyles (occasionally styles), straight to slightly curved, often with microspined base, 120–340 × 2.5 μm. Microscleres of palmate isochelas (not very abundant), 18–21 μm; toxas, long, smooth, straight

arms with low, compressed arch (which may be irregularly bent), 105–520 × 0.5–1.0 μm; toxiform oxeas, straight to irregularly bent, bend often resembles arches of the toxas, 450–800 × 3–6 μm (Fig. 2F). Toxas and toxiform oxeas may represent a gradational series, but are morphologically distinguishable. Toxiform oxeas included as microscleres following past convention (see Taxonomic discussion).

Taxonomic discussion.—The generic determination of this sponge has been problematical. There have been earlier records, from other parts of the world, of sponges showing affinities with the California sponge, but there has not been general agreement on their systematic position. For a review of these species see: Ridley & Dendy (1887:124–127, *Amphilectus apollinis*, *A. pilosus*); Hallman (1919:772–773, *Megaciella pilosus*, *Tenaciella canaliculata*); Babic (1922:259–261, *Artemisina*? *paradoxa*).

Tenaciella canaliculata (Whitelegge) possessed spicules of isochelas, and toxas (which form a series from small toxa up to large forms that resemble "rhapidiform oxea"). The spicule complement of *T. canaliculata* appears identical to *Artemisina archegona*, but the California sponge differs in the shape of the toxas, the skeletal construction and growth form.

Artemisina ? *paradoxa* Babic, possessed large "toxenartige Diactine" (toxen-resembling oxea) which were claimed to resemble those of *Amphilectus pilosus* [= *Megaciella pilosus* (Ridley & Dendy)].

Burton (1930:528), in an extensive definition of the genus *Artemisina*, claimed that *Amphilectus apollinis* Ridley & Dendy, really belonged in the genus *Artemisina* and that *Artemisina paradoxa* Babic, belonged in the genus *Clathria*. Burton listed many species that he felt belonged in the genus *Artemisina*, but did not mention the type-species of *Megaciella* or *Tenaciella*. Based on his definition however, they apparently could be classed as such.

Contrary to Burton, de Laubenfels (1936:117–118) placed the genus *Artemisina* into a new family, the Ophlitaspongiidae (which have enchinating spicules). De Laubenfels stated that *Artemisina* is characterized, in part, by spiny-ended toxas. De Laubenfels (p. 123) erected a new family, the Amphilectiidae (which do not have echinating spicules), and placed Hallman's genus, *Tenaciella*, in this family (p. 126).

Levi (1960) rejected de Laubenfel's division of the Clathriidae and thus rejected the family Ophlitaspongiidae. Levi (p. 83) discussed the genus *Artemisina*, and his diagnosis is essentially the same as Burton's. Levi did not mention sigmas as being part of the microscleres however and the forms he has assigned to this genus indicate that the toxas may or may not have spined ends. Levi did not discuss the genus *Tenaciella* or the family Amphilectiidae.

Apparently, a variety of sponges possess toxiform oxeote spicules, and the occurrence of such may not be indicative of a particular genus. The Cali-

fornia sponge fits Levi's description of *Artemisina* and I have tentatively placed it here. It should be kept in mind that the genus *Tenaciella* has not been synonomized (to my knowledge) and conceivably may be valid. If further work proves it to be distinct from *Artemisina*, the generic placement of *A. archegona* possibly may have to be reviewed.

In California waters, *A. archegona* is easily recognized, for no other west coast species has toxiform oxeas or toxas of this particular shape. Inasmuch as this is the first record of an *Artemisina* from this area, the specific name has been formed from the root word "archegon," which means "first of a race" (see Jaeger, 1963).

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Bodega Marine Laboratory, Bodega Bay, California 94923.

Footnote

[1] This word was coined to characterize aggregations of sponges. Its usage is comparable to other such nouns that define animal groups (i.e. gaggle, school, etc.). It was originally developed and defined by Ristau (1977).